Unit 6 Experiments

UNIT OBJECTIVE

When you have completed this unit, you will be able to:

1. Describe the definitions of acceleration, gravitational acceleration, roll, and pitch.
2. Set up the hardware in appropriate configuration.
3. Demonstrate the measurement of gravity.
4. Measure the 3-axis gravitational acceleration waveforms.
5. Measure gravitational acceleration and tilt angle.
6. Calculate gravitational acceleration and calibrate offset.
7. Demonstrate the pitch and roll rotation.

EQUIPMENT REQUIRED

1. KL-67001 3-Axis Accelerometer Unit
2. KL-67101 XY-Axis Angle Plate
3. KL-67102 XYZ-Axis Rotation Stand

DISCUSSION

The following introduces four terms: acceleration, gravitational acceleration, roll, and pitch.

Acceleration

In classical physics, acceleration is a vector quantity which measures the change in velocity in a unit of time. The SI unit of velocity is expressed in meters per second (m/s) and includes both the rate of displacement and direction of movement. It follows that acceleration is measured in meters per second squared (m/s^2).

Gravitational Acceleration

The acceleration of gravity or gravitational acceleration (g) differs from the upper-case letter "G", which is the gravitational constant of Universal Gravitation. Gravitational acceleration resulting from Universal Gravitation will be affected by the gravity of the Earth and Moon, and the centrifugal force produced by the Earth spinning. Gravitational acceleration varies from location to location on the Earth depending on altitude (the height above sea level) and latitude. For example, the gravitational acceleration at the Equator's sea level is $9.83 m/s^2$, and is about $9.78 m/s^2$ at the North Pole.

Before 1935, the World Meteorological Organization (WMO) defined one gravitational acceleration $1g = 9.8\ m/s^2$. After 1935, WMO redefined the gravitational acceleration $9.80665\ m/s^2$ at the sea level at latitude of 45º (or written as g_{45}). However, advances in measurement technology have found g_{45} no longer equal to $9.80665\ m/s^2$. To remain $1g = 9.80665\ m/s^2$ unchanged, now the gravitational acceleration is $9.80665\ m/s^2$ at latitude of 45.542º.

In automotive aerodynamics and aircraft aerodynamics, the g value (g-force) used for designing race cars or aircrafts stands for the centrifugal force. For example, when you drive a car to pass a right hand curve, there is a force that pulls your body toward the left. This pull force is called the centrifugal force. Generally, when a car turns a 30º sharp bend in the road at the speed of 60km/h, the centrifugal force of about 1g will be produced.

Roll

In flight, the longitudinal axis of an aircraft is the straight line from nose to tail through the aircraft's center of gravity. Rotation about the longitudinal axis (front-to-back axis) is called roll. Roll rotation is produced and controlled by the ailerons, as shown in Fig. 6-1. Controlling the ailerons produces different lift forces on the left and right wings so that the aircraft rotates about the longitudinal axis.

Roll angle is the angle between the horizontal plane and the actual flight orientation. When the right wing of the aircraft is down in relation to the left wing, the roll angle is positive.

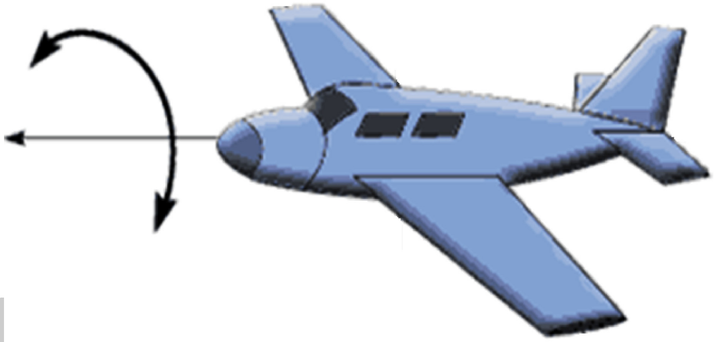

Fig. 6-1 Roll rotation

Pitch

In flight, the lateral axis of an aircraft is the straight line from side to side of the aircraft. Rotation about the lateral axis (side-to-side axis) is called pitch. Pitch rotation is produced and controlled by the elevators, as shown in Fig. 6-2. Controlling the elevators changes the flight orientation. If the nose of the aircraft is over the horizontal plane, the angle between nose and the horizon is called the angle of elevation. On the contrary, if the nose is below the horizontal plane, the angle between nose and the horizon is called the angle of depression.

Pitch angle is the angle between an aircraft's lateral axis and the horizontal plane. When the nose of the aircraft is pointed up, the pitch angle is positive.

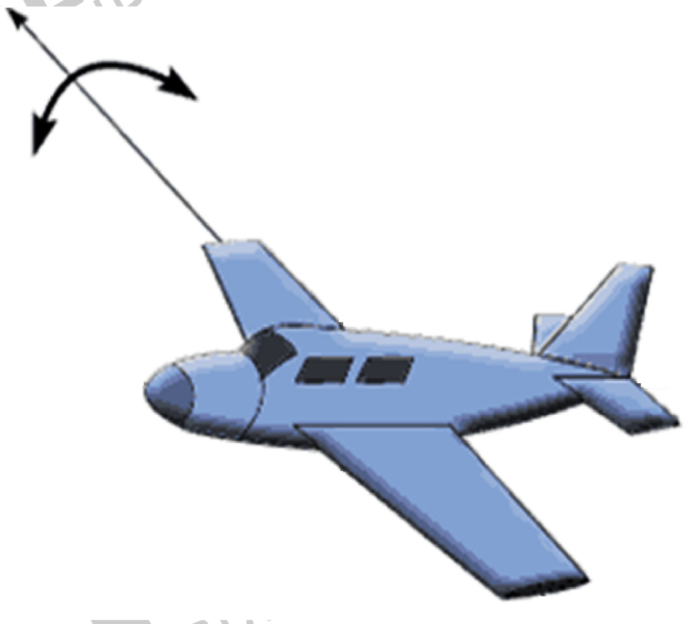

Fig. 6-2 Pitch rotation

Hardware Setup

In the following experiments, you will utilize the KL-67001 3-Axis Accelerometer Unit, KL-67102 XYZ-Axis Rotation Stand, and KL-67101 XY-Axis Angle Plate in the configurations below.

Configuration 1

1. Install the KL-67001 3-Axis Accelerometer Unit in the inner gimbal of the KL-67102 XYZ-Axis Rotation Stand.

2. Place the KL-67101 XY-Axis Angle Plate in front of the Y-Axis Rotary knob, as shown in Fig. 6-3.

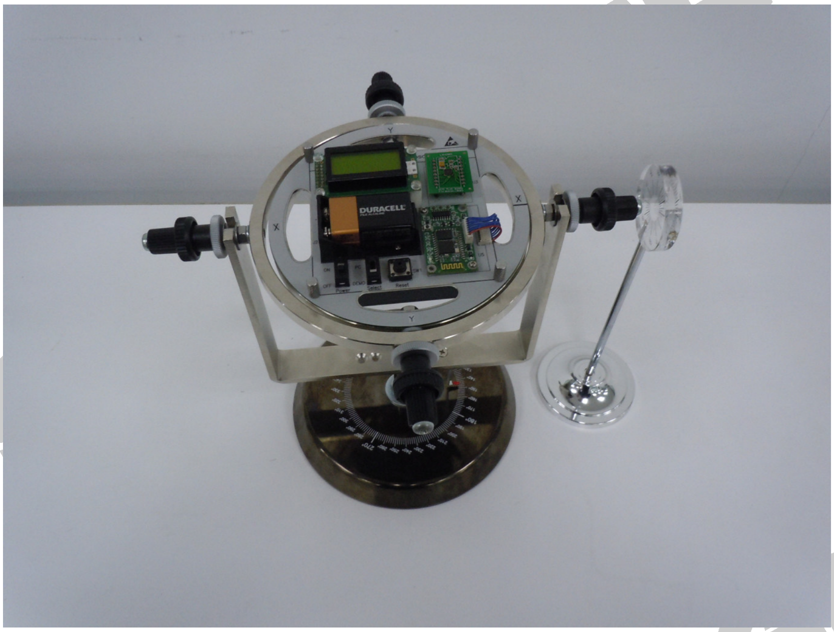

Fig. 6-3 Configuration 1

Configuration 2

1. Install the KL-67001 3-Axis Accelerometer Unit in the inner gimbal of the KL-67102 XYZ-Axis Rotation Stand.

2. Place the KL-67101 XY-Axis Angle Plate in front of the X-Axis Rotary knob, as shown in Fig. 6-4.

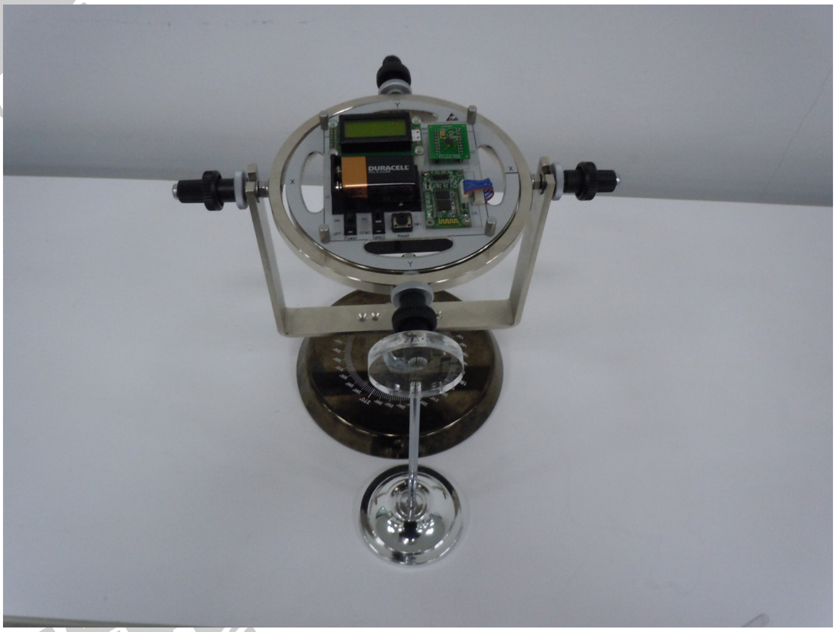

Fig. 6-4 Configuration 2

Experiment 3 Gravitational Acceleration Calculation and Offset Calibration

PROCEDURE

1. Lay the KL-67001 3-Axis Accelerometer Unit flat on a level table.

2. Set the Select switch to PC.

3. Turn on the power. The LCM will display "PC".

4. Run KL-67001 program. At the Main screen, click "Gravitational acceleration" to open Gravitational Acceleration window. In the Gravitational Acceleration window, click "Calculate" to select the Gravitational Acceleration Calculation and Offset Calibration experiment. The Gravitational Acceleration Calculate window opens as shown in Fig. 6-6.

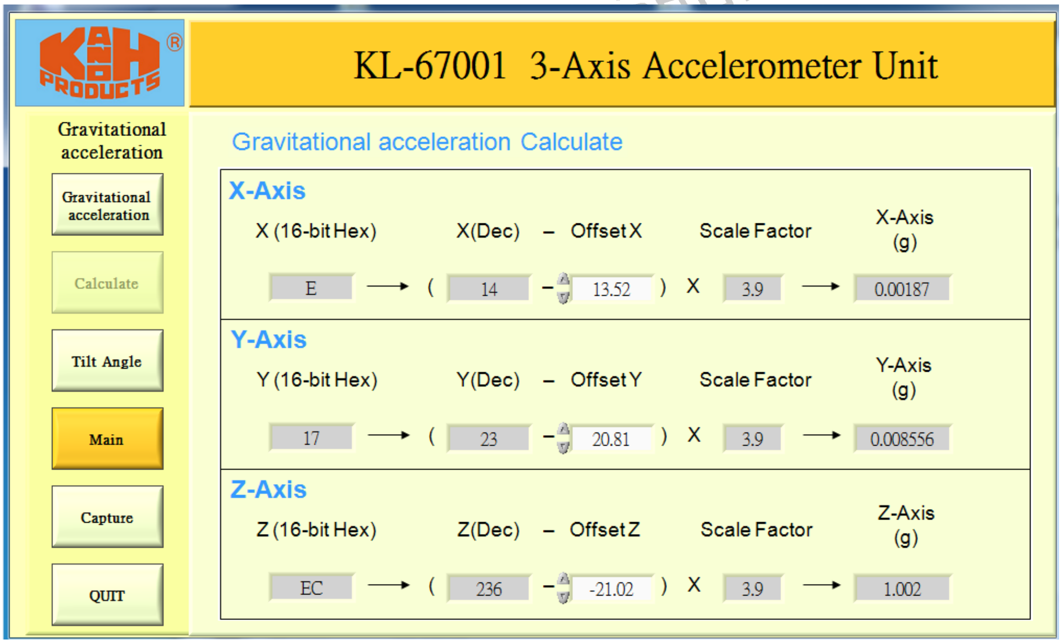

Fig. 6-6 Gravitational Acceleration Calculate window

5. The software starts to read, calculate and display gravitational acceleration data for each axis.

6. In the X-Axis pane, adjust Offset X to make X-Axis (g) =0.

7. In the Y-Axis pane, adjust Offset Y to make Y-Axis (g) =0.

8. In the Z-Axis pane, adjust Offset Z to make Z-Axis (g) =1.

9. Record the Offset X, Offset Y, and Offset Z values in Table 6-3.

Table 6-3

Offset X	Offset Y	Offset Z

10. State about Offset X, Offset Y, and Offset Z.